(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **09094954 A**

(43) Date of publication of application: **08.04.97**

(51) Int. Cl **B41J 2/045**
B41J 2/055
B41J 2/16

(21) Application number: **07251285**

(22) Date of filing: **28.09.95**

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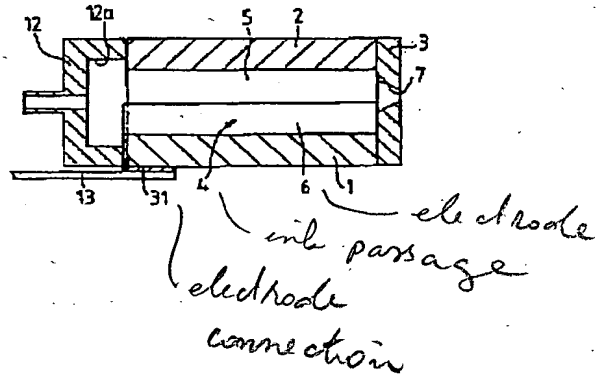
(54) **INK JET RECORDING APPARATUS**

(57) Abstract:

PROBLEM TO BE SOLVED: To achieve the miniaturization, wt. reduction and cost reduction of an ink jet recording apparatus using a passage substrate composed of a piezoelectric material.

SOLUTION: An electrode 6 is formed to the lower half part of the side surface of the passage partition wall 5 of a passage substrate 11 composed of a piezoelectric material and having ink passages 4 formed thereto. The electrode connection part 31 drawn out to the bottom surface of the passage substrate 1 from the electrode 6 through the end surface of the passage substrate is formed to the passage substrate 1. A cover plate 2, a nozzle plate 3 and an ink supply manifold 12 are bonded to the passage substrate 1. A voltage supply cable 13 is connected to the electrode connection part 31 provided to the bottom surface of the passage substrate. Since an electrical connection part or a common ink chamber 12a is not positioned on the surface (upper surface) of the passage substrate but not positioned on the bottom surface thereof, the miniaturization and wt. reduction of an ink jet recording apparatus can be achieved and the cost reduction thereof is achieved by the reduction of the use amt. of the piezoelectric material.



(19)日本国特許庁（ＪＰ）　(12)公開特許公報(A)　(11)特許出願公開番号
特開平9－94954
(43)公開日　平成9年(1997)4月8日

(51)Int.Cl.⁶	識別記号	庁内整理番号	FI		技術表示箇所
B41J	2/045		B41J	3/04	103A
	2/055				103H
	2/16				

審査請求 有　請求項の数6 OL （全 8 頁）

(21)出願番号　特願平7－251285
(22)出願日　平成7年(1995)9月28日

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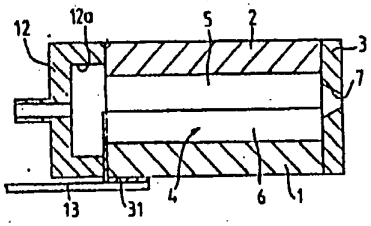
(54)【発明の名称】　インクジェット記録装置

(57)【要約】
【目的】　圧電材料からなる流路基板を用いるインクジェット記録装置の小型化、軽量化、低コスト化を達成する。
【構成】　圧電材料からなりインク流路４が形成された流路基板１の、流路隔壁５側面の下半分に電極６が形成される。電極６からは流路基板１端面を経て底面まで引き出された電極接続部３１が形成される。流路基板１にカバープレート２とノズルプレート３とインク供給用マニフォールド１２とが接合される。電圧供給用のケーブル１３は流路基板の底面に設けられた前記電極接続部３１に接続される。電気的接続部分や共通インク室１２ａが、流路形成面（上面）でなく底面に位置しているので、小型軽量化でき、圧電材料の使用量の減少により低コスト化できる。



【特許請求の範囲】
【請求項１】　少なくとも一部が圧電材料からなり、複数の溝状のインク流路が刻設されているとともに、上記各インク流路に対応して複数の電極が設けられている流路基板と、
上記流路基板の上記インク流路形成面に固着されているカバープレートと、
上記流路基板の一端面に固着されており、上記各インク流路の開口端とそれぞれ連通する複数のノズルを有するノズルプレートと、
上記各電極から延伸しかつ屈曲して上記流路基板の端面に引き出されている電極接続部とを有することを特徴とするインクジェット記録装置。
【請求項２】　上記電極接続部は、上記各電極から延伸しかつ屈曲して上記流路基板の端面に引き出された後、さらに延伸しかつ屈曲して上記流路基板の底面にまで引き出されていることを特徴とする請求項１に記載のインクジェット記録装置。
【請求項３】　上記底面には、上記電極接続部と接続される駆動回路素子が設けられていることを特徴とする請求項２に記載のインクジェット記録装置。
【請求項４】　上記電極接続部は、上記端面または上記底面に形成された溝内に金属膜が形成されたものであることを特徴とする請求項１～３のいずれかに記載のインクジェット記録装置。
【請求項５】　上記流路基板の端面のうちのいずれか一方には、上記各インク流路にインクを供給する共通インク室を有するマニフォールドが固着してあることを特徴とする請求項１～４のいずれかに記載のインクジェット記録装置。
【請求項６】　複数の上記電極接続部は、上記流路基板の一方の端面側と他方の端面側とに交互に形成されていることを特徴とする請求項１～５のいずれかに記載のインクジェット記録装置。
【発明の詳細な説明】
【０００１】
【発明の技術分野】本発明は、インク滴の吐出によって記録を行なうインクジェット記録装置に関するものである。
【０００２】
【従来の技術】従来、圧電材料そのものにインク流路を形成するインクジェット記録装置が特開平２－１５０３５５号公報等に開示されている。このようなインクジェット記録装置の、流路に垂直な方向の断面図を図２１に、インク流路に沿った方向の断面図を図２２に示す。この記録装置は、厚み方向に分極された圧電材料からなる流路基板５０に切削加工等により複数の溝状のインク流路５１を刻設し、それら複数のインク流路を区画している流路隔壁５２の両側面に電極５３を形成した後、この流路基板上面にカバープレート５４を接合し、インク滴を吐出するためのノズル５５が形成されたノズルプレート５６を流路基板５０の流路出口端面に接合することにより、各インク流路５１を各ノズル５５にそれぞれ連通させて構成されている。電極５３は、流路基板５０上のインク流路５１が形成された面の流路後方にまで引き出されて電極接続部５７となっており、そこで外部電気回路（図示せず）と電気的に接続されている。この電極５３に駆動電圧が供給されると流路隔壁５２内に分極方向５８とは垂直の電界が発生し、流路隔壁５２が剪断モードで流路５１内側へ向かって撓み流路内のインクを加圧しノズル５５よりインクの吐出を行なう。また、吐出により消費された分のインクは、前記カバープレート５４（または流路基板５０）に設けられた共通インク室５９を介して補給される。
【０００３】これらのインクジェット記録装置は、圧電材料からなる流路基板を用い流路基板自身が圧力発生手段となっているため、圧力源を他に設ける必要がなく、流路およびにノズルの高密度化に優れている。
【０００４】
【発明が解決しようとする課題】しかしながら、これら従来のインクジェット記録装置は流路基板５０の流路刻設面と同一面上に外部電気回路との電極接続部５７が設けられているのに加え、カバープレート５４内または流路基板５０内に共通インク室５９が形成されている。すなわち、流路６１自体は流路基板５０の一端面から中間部までしか形成されておらず、その後方に電極接続部５７および共通インク室５９が存在している。従って、本来インク滴を射出するのに必要なインク流路（加圧部）５１の長さよりも、流路基板５０ならびにカバープレート５４の長さが非常に大きなものとなっており、小型化、軽量化の妨げとなっていた。図２２を用い具体的に説明すると、インク滴を吐出するために用いられるインク流路（加圧部）はノズル側端面から共通インク室５９までの図中にＬで示した部分であり、通常Ｌ＝２～１０ｍｍ程度の長さとなっているのに対して、共通インク室５９と電極接続部５７を含む流路基板の全長は１５～２５ｍｍになっている。このように、従来のインクジェット記録装置では流路方向の長さを短くするのが困難で小型、軽量化の妨げになっていた。また、インクジェット記録装置主要部を構成する素材の中で、圧電材料は最も高価なものであり、従来方法では圧電材料の使用量が多いためコスト高の要因となっていた。また、従来構成ではインク流路（加圧部）５１に加え、共通インク室５９と電極接続部５７においても電極間で電気容量を形成し、必要以上に消費電流及び電力が増大していた。
【０００５】本発明は上記課題を解決するもので、少なくとも一部が圧電材料からなる流路基板を用い、流路基板自身が圧力発生手段となっているインクジェット記録装置において、小型化、軽量化、低コスト化、および低消費電力化の達成を目的とする。

【0006】

【発明を解決するための手段】上記目的を達成するために、本発明では、少なくとも一部が圧電材料からなり複数の溝状のインク流路が刻設されているとともに各インク流路に対応して複数の電極が設けられている流路基板と、流路基板のインク流路形成面に固着されているカバープレートと、流路基板の一端面に固着されており各インク流路の開口端とそれぞれ連通する複数のノズルを有するノズルプレートと、各電極から延伸しかつ屈曲して流路基板の端面に引き出されている電極接続部とを有することを特徴とするものである。なお、電極接続部は、各電極から延伸しかつ屈曲して流路基板の端面に引き出された後、さらに延伸しかつ屈曲して流路基板の底面にまで引き出されている場合もある。この場合、底面に、電極接続部と接続される駆動回路素子を設けることもできる。電極接続部は、端面または底面に形成された浅溝内に金属膜が形成されたものであると製造が容易にできる。好ましくは、流路基板の端面のうちのいずれか一方には、各インク流路にインクを供給する共通インク室を有するマニフォールドが固着される。複数の電極接続部は、流路基板の一方の端面側と他方の端面側とに交互に形成することもできる。

【0007】

【発明の実施の形態】以下、本発明の詳細を添付図面に沿って説明する。図1は本発明の第1の実施例の流路方向に沿った断面図、図2は本発明の第1の実施例を流路後方より見た背面図である。

【0008】本発明によるインクジェット記録装置の主要部は、圧電材料よりなる流路基板1と、流路基板上面に接合されたカバープレート2と、流路基板1の一端面に接合されたノズルプレート3により構成されている。流路基板1上面には切削加工等により複数の溝状のインク流路4が刻設され、このインク流路4は流路基板1の端面に開口している。インク流路4を区画している流路隔壁5の両側面には電極6が形成されている。また、流路基板1の端面にノズルプレート3が固着してあり、このノズルプレート3に、各インク流路4に連通しインク滴を吐出するノズル7が形成されている。流路基板1とカバープレート2の流路方向の長さは、インクに圧力を加える部分であるインク流路4の長さしと実質的に等しく構成されている。また、電極6は、インク流路4全長にわたって形成され、さらにこのインク流路4と直角に位置する流路基板1端面（本実施例においてはノズルプレート3とは反対側の流路後方端面）にも連続的に形成されている。

【0009】次に、この第1の実施例のインクジェット記録装置に用いる流路基板1の製造方法を図3を用いて説明する。なお、図3は第1の実施例に用いる流路基板1の製造方法を説明する工程図であり流路基板後方端面の正面図となっている。まず、第1の工程として、PZT等の圧電材料からなり厚み方向に分極されている基板1に、図3（a）に示すようにダイシングソー等の機械切削加工によって複数の概ね平行な溝状のインク流路4を形成する。流路基板1は、長さ2mm～10mm、厚み0．5～2mm程度で、流路深さは例えば200μm～1mm、流路幅は例えば50μm～200μm、流路を区画する隔壁5の厚みは例えば50μm～200μmである。

【0010】第2の工程は、図3（b）に示したように流路が加工された流路基板1に、スパッタまたは無電解メッキ等で電極膜6aを流路4内を含む全面に形成する。電極素材は、Al、Ni、Cr、Au等で0．1μm～3μmの厚みで形成する。第3の工程は、電極6の分離形成である。本実施例においては、圧電性の流路基板1は基板厚み方向に分極され、分極方向8と垂直な電界を流路隔壁5に印加することによって隔壁5が剪断モードでインク流路4内側へ向かって変形し、インク滴がノズル7より吐出される。このインク吐出を効率的に行うために、電極6は流路隔壁5の高さ方向の概ね半分まで形成されている必要があり、図3（c）に示したように、YAGレーザーやF_2、ArF、KrF、XeCl、XeF等のエキシマレーザーによるレーザー光9aを流路基板1流路面に斜めに照射し、流路隔壁5自体をマスクとして用いることにより流路面の電極膜6aを概ね上半分だけ除去し、下半分に所望の形状の電極6を得ることができる。

【0011】また、ノズルプレート3とは反対側の流路後方端面は、リン青銅等の金属マスク10により必要部を保護したうえで前記レーザー光9bを照射し、図3（d）に示したような、外部電気回路（図示せず）から電力を供給するための電極接続部11を分離形成する。このようにして、所望の電極6と電極接続部11とが形成された流路基板1を得ることができる。なお、流路基板1のノズル側端面と、流路4と平行な両端面と、底面とに設けられた電極膜6aは、前記レーザーの全面照射、または機械的研磨によって除去する。

【0012】このようにして作成された流路基板1に、PZT、セラミックス、ガラス、プラスチック等で、厚み0．2～2mm程度のカバープレート2を例えばエポキシ系接着剤で接合する。

【0013】次に、ポリイミドフィルムを材料としてレーザー照射により加工して形成したり、または金属を材料として電鋳やマイクロプレス方式で形成したノズルプレート3を流路基板1端面に接合し、各ノズル7を各インク流路4に連通させて、図1に示した本実施例のインクジェット記録装置の主要部が完成する。

【0014】次に、共通インク室12aを内部に持つインク供給用マニフォールド12を流路後方端面に接合する。最後に前記電極に外部電気回路（図示せず）から電圧波形を供給するための配線がなされたFPCまたはヒートシール等のケーブル13を流路基板1の端面に設けられた前記電極接続部11に接続し、図4に示した本実施例のインクジェット記録装置が完成する。

【0015】この実施例によれば、従来の方法では15mm～25mmと大きなものになっていた流路基板1の長さが、インク流路4の長さと実質的に等しい2mm～10mmと大幅に小さくすることができ、インクジェット記録装置を従来の半分以下に小型、軽量化できる。また、流路基板1を形成する圧電性材料は原材料の中で最も高価なものであるが、小型化したことにより原材料費が半減し、インクジェット記録装置を低コスト化することができる。また、小型化したことにより、インク流路部以外の付加容量が減少し、低消費電力化することができる。

【0016】図5には本発明の第2の実施例であるインクジェット記録装置に用いられる流路基板14の製造方法を説明する工程図を、図6に第2の実施例の主要部の流路後方部の斜視図を示している。第2の実施例のインクジェット記録装置に用いる流路基板14の製造方法を、流路後方端面より見た図5を用いて説明する。なお、材料名、寸法等記載のないものは第1の実施例と同じである。第1の工程は、図5（a）に示したように圧電性の流路基板14にダイシングソー等の機械切削加工によって複数の概ね平行な溝状のインク流路4を形成する。次に、流路4が形成された面と直角をなす端面に、各流路4に連なった浅溝15を機械加工する。浅溝15の深さは、必要条件としては電極の膜厚最大値の3μm以上であるが、機械加工精度を考慮し5μm以上が望ましい。また、あまり深すぎるとケーブル13との電気的接続に支障を来たすため30μm以下とするのが望ましい。浅溝15の幅は流路部とほぼ同じ例えば50μm～200μmである。

【0017】第2の工程は、図5（b）に示したように流路4が加工された圧電性流路基板14にスパッタまたは無電解メッキ等で電極膜16aを全面に形成する。そして第3の工程は、電極16の分離形成である。YAGレーザーやF2、ArF、KrF、XeCl、XeF等のエキシマレーザーなどのレーザー光17を流路基板流路面に斜めに照射し、流路隔壁5自体をマスクとして用いることにより流路面の電極膜16aを概ね上半分だけ除去することができる。

【0018】また、流路後方の端面を機械的方法で浅溝15が無くならない程度に研磨すると、浅溝15内の電極膜のみが残り、図5（c）に示したように、流路端面に外部電気回路から電力を供給するための電極接続部18が分離形成される。

【0019】この実施例によれば、第1の実施例で用いたような流路後方端面に電極パターンを形成するための金属マスクが不必要になり、製造工程を簡略化できる。

【0020】図7に第3の実施例を流路後方より見た背面図を示す。第3の実施例では分極方向19の異なった2枚の圧電性基板20a，20bを張り合わせた流路基板20が用いられているため、流路隔壁の上下の剪断モードによる変形方向が同一になるため、電極21を半分だけ除去する必要がなくなり、さらに製造工程を簡便化できる。

【0021】図8に第4の実施例を流路後方より見た背面図を示す。第4の実施例では、圧電性流路基板22に作成された各流路4の下部に凸部23が設けられ、凸部上面に設けられた電極24と下部に設けられた電極25の間に電圧が印加されると、凸部中に分極方向26と平行な電界が発生し、圧電縦モードで凸部23が図面上方へ向かって変形し、インク流路中のインクに圧力が発生しインク滴が吐出される。凸部上面の電極24は、前記方法と同一の方法で流路基板22の流路4と垂直な端面に引き出され、端面で外部電気回路と電気的な接続がなされる電極接続部27となっている。このように、本発明は剪断モードを用いたインクジェット記録装置に限らず適用できる。

【0022】図9に第5の実施例の流路方向に沿った断面図を示す。第5の実施例では、流路基板1のノズルプレート3が接合される面と同一の端面に電極6が引き出され、ノズルプレート側端面上で電極接続部28とケーブル13との電気的接続がなされている。この構成によって、ケーブル配線の柔軟性が増し、さらに記録装置全体を小型化できる。なお、電極接続部29の存在しない部分で流路基板1とノズルプレート3との間に若干の隙間が生じる場合、ノズルプレート3接着用の接着剤を充填してシールする。

【0023】図10に第6の実施例の流路方向に沿った断面図を示す。第6の実施例では、電極6が、流路おきに、流路基板1のノズルプレート3が接合される端面と反対側の端面との両端面に交互に引き出され、両端面上で電極接続部29，30とケーブル13との電気的接続がなされ外部電気回路と接続されている。従来、流路ピッチが約100μm以下になると困難であった電極接続が、この構成を取ることによって、電極接続部のピッチを流路ピッチの倍にすることができ、高精細な記録装置を実現できる。

【0024】図11～14に第7の実施例を示している。電極6は、インク流路4内と流路基板1端面を経て、流路基板底面（流路形成面と反対側の面）にまで引き出されている。すなわち、圧電材料からなりイング流路4が形成された流路基板1に、電極膜6aを底面を含む全面に形成する。図3（a）に示したような、レーザー光9aを流路基板流路面に斜めに照射し、流路隔壁5自体をマスクとして用いることにより流路面の電極6aを概ね上半分だけ除去し、下半分に電極6を残す。また、ノズルプレート3とは反対側の流路後方端面と、流路基板底面とは、リン青銅等の金属マスク32により必

要部を保護したうえでレーザー光９ｂを照射し、図３（ｂ）に示したような、外部電気回路から電力を供給するための電極接続部３１を形成する。なお、流路基板のノズル側端面と、流路と平行な両端面の電極膜６ａは、前記レーザーの全面照射、または機械的研磨によって除去する。

【００２５】この流路基板１にカバープレート２とノズルプレート３とを接合し、インクジェット記録装置の主要部が完成する。そして、共通インク室１２ａを内部に持つインク供給用マニフォールド１２を流路後方端面に接合する。最後に電圧供給用のケーブル１３を流路基板の底面に設けられた前記電極接続部３１に接続し、図１４に示した本実施例のインクジェット記録装置が完成する。

【００２６】図１５，１６に第８の実施例を示している。第８の実施例は、図１５（ａ）に示したように、流路基板の流路が形成された面と直角をなす端面と底面とに、電極接続部を形成すべき位置に、各流路１１に連なった浅溝３４を形成した上で、電極膜３５ａを全面に形成する。そして、図１５（ｂ）に示したように、レーザー光３６を照射して流路隔壁５側面に電極６を形成するとともに、浅溝３４が形成された端面と底面を機械的方法で浅溝３４が無くならない程度に研磨する。これにより浅溝３４内の電極膜のみが残り、図１５（ｃ）に示したように、流路基板３３底面に外部電気回路から電力を供給するための電極接続部３７が形成される。

【００２７】図１７に第９の実施例を流路後方より見た正面図を示す。第９の実施例では分極方向の異なった２枚の圧電性基板３８ａ，３８ｂを張り合わせた流路基板３８が用いられているため、流路隔壁の上下の剪断モードによる変形方向が同一になるため、電極３９を半分だけ除去する必要がなくなり、さらに製造工程を簡便化できる。

【００２８】図１８に第１０の実施例の流路方向に沿った断面図を示す。第１０の実施例では、流路基板１のノズルプレート３が接合される面と同一の端面を経由し流路基板１の底面まで電極が引き出され、流路基板１底面のノズルプレート側で外部電気回路との電極接続部４１がなされている。この構成によって、流路後方に設けられた、共通インク室１２ａを内部に持ったインクを供給するためのマニフォールド１２と電極接続部４１を分離できるため、マニフォールド１２とインクジェット記録装置上要部のインクシーリングの信頼性を向上させることができる。

【００２９】図１９に第１１の実施例の流路方向に沿った断面図を示す。第１１の実施例では、各電極から１流路おきに、流路基板１の２つの端面を交互に経由し、流路基板の底面の少なくとも一部まで引き出され、電極接続部４２，４３が設けられている。そして、流路基板１の底面上で電極接続部４２，４３とケーブル１３との電気的接続がなされている。従来、流路ピッチが約１００μｍ以下になると困難であった電極接続が、この構成を取ることによって、電極接続部のピッチを流路ピッチの倍にすることができ、５０μｍ程度の流路ピッチでも電極接続が可能で、高精細な記録装置を実現できる。

【００３０】図２０に第１２の実施例の流路流路方向に沿った断面図を示す。第１２の実施例では、流路基板１底面に駆動回路素子４４、いわゆるＩＣが接合されている。駆動回路素子４４の出力部は、ワイヤーボンディング等で、流路基板の端面を経由し流路基板の底面まで引き出された電極接続部４３と電気的に接続される。駆動回路素子への制御信号及び電力は、外部電気回路（図示せず）から、ケーブル１３を介し供給される。駆動回路素子４４にデータをシリアル転送することによって、外部電気回路からインクジェット記録装置につながる電気的配線数を大幅に低減できる。この実施例では、従来用いられていなかった流路基板底面を利用するため、流路基板１及びインクジェット記録装置全体を大型化することなく、駆動回路素子４４を搭載することが可能になる。

【００３１】

【発明の効果】以上のように本発明では、少なくとも一部が圧電材料からなる流路基板を用い、各インク流路に対応して電極が形成してあるインクジェット記録装置において、各電極から流路基板の端面または底面まで引き出された電極接続部が形成してあるので、外部駆動回路との電気的接続が端面または底面で行われ、インク流路形成面上には電気的接続のためのスペースを設ける必要がなく、流路基板とカバープレートを、インク流路と実質的に同程度の長さとすることができる。従って本発明によれば、インクジェット記録装置を従来の半分以下に小型、軽量化でき、小型化したことにより原材料費が減小し、特に高価な圧電材料の使用量が減るため、安価なインクジェット記録装置が提供可能になる。さらに小型化したことにより、付加容量が減少し低消費電力化が可能になる。また、共通インク室を流路形成面上に共通インク室を設けるのではなく、共通インク室を有するマニフォールドを流路基板端面に固着する構成とするとさらに効果的である。電極接続部を流路基板底面に設ける場合には、形流路基板及びインクジェット記録装置を大型化することなく、駆動回路素子を搭載することが可能になる。

【００３２】流路基板端面または底面に形成された浅溝内に金属膜を形成して電極接続部を構成すると、製造工程が簡単になる。複数の上記電極接続部を、流路基板の一方の端面側と他方の端面側とに交互に形成すると、流路ピッチよりも電気的接続部分のピッチを倍の大きさにできるため、インク流路の高密度化に寄与する。

【図面の簡単な説明】

【図１】本発明の第１の実施例の流路方向に沿った断面図である。

【図２】第１の実施例を流路後方より見た背面図である。

【図３】第１の実施例の流路基板の製造方法の説明図である。

【図４】第１の実施例の装置全体の断面図である。

【図５】第２の実施例の流路基板の製造方法の説明図である。

【図６】第２の実施例の要部の流路後方部の斜視図である。

【図７】第３の実施例を流路後方より見た背面図である。

【図８】第４の実施例を流路後方より見た背面図である。

【図９】第５の実施例の流路方向に沿った断面図である。

【図１０】第６の実施例の流路方向に沿った断面図である。

【図１１】第７の実施例の流路方向に沿った断面図である。

【図１２】第７の実施例を流路後方より見た背面図である。

【図１３】第７の実施例の流路基板の製造方法の説明図である。

【図１４】第７の実施例の装置全体の断面図である。

【図１５】第８の実施例の流路基板の製造方法の説明図である。

【図１６】第８の実施例の要部の流路後方部の斜視図である。

【図１７】第９の実施例を流路後方より見た背面図である。

【図１８】第１０の実施例の流路方向に沿った断面図である。

【図１９】第１１の実施例の流路方向に沿った断面図である。

【図２０】第１２の実施例の流路方向に沿った断面図である。

【図２１】従来例の流路に垂直な方向の断面図である。

【図２２】従来例の流路方向に沿った断面図である。

【符号の説明】

１，１４，２０，２２，３３，３８・・・流路基板

２・・・カバープレート

３・・・ノズルプレート

４・・・インク流路

５・・・流路隔壁

６，２１，２４，２５，３９・・・電極

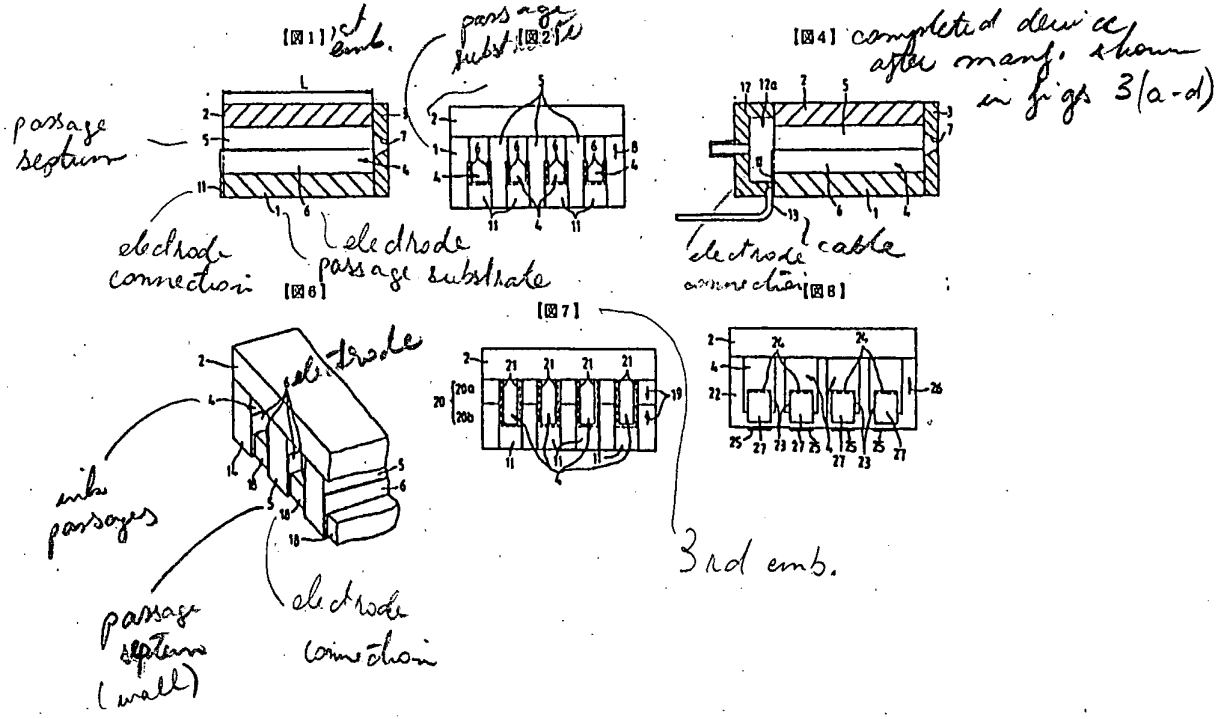
７・・・ノズル

１１，１８，２７，２８，２９，３０，３１，３７，４１，４２，４３・・・電極接続部

１２・・・マニフォールド

１２ａ・・共通インク室

１５，３４・・・浅溝

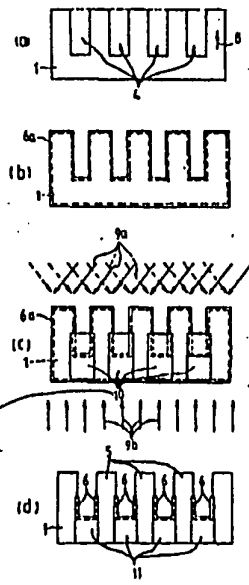


manf. of fig 1 & 2

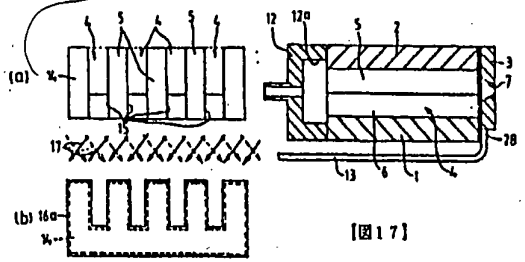
2nd emb. / manf. of fig 6

passage substrate

【図3】

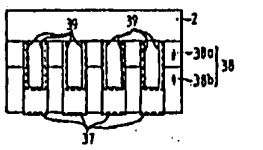


【図6】

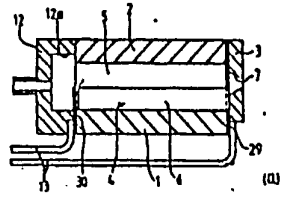


【図9】

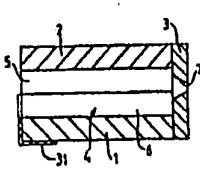
【図17】



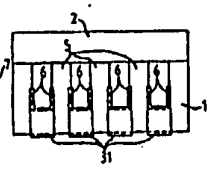
【図10】



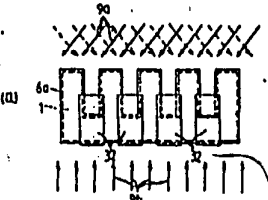
【図11】



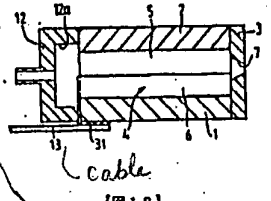
【図12】



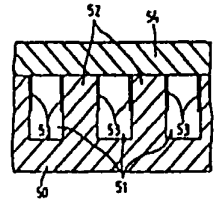
【図13】



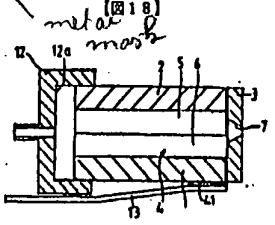
【図14】



【図21】P.A



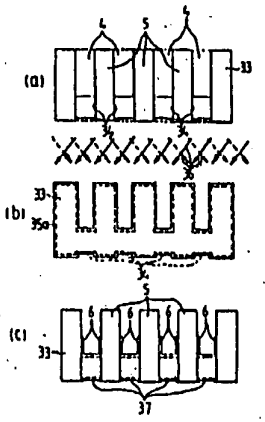
【図18】



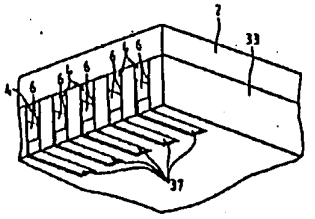
cable

metal mask

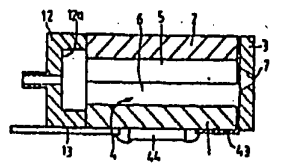
【図15】



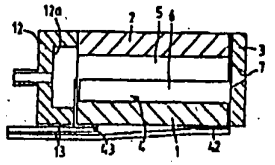
【図16】



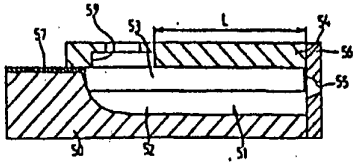
【図20】



【図19】



【図22】P.A.



translation for JP 09-094954

* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] The ink-jet recording device characterized by providing the following. The passage substrate in which two or more electrodes are prepared corresponding to each above-mentioned ink passage while at least a part consists of piezoelectric material and the ink passage of the shape of two or more slot is engraved. The cover plate which has fixed to the above-mentioned ink passage forming face of the above-mentioned passage substrate. The nozzle plate which has fixed to the end side of the above-mentioned passage substrate, and has the opening edge of each above-mentioned ink passage, and two or more nozzles which are open for free passage, respectively. The electrode connection which extends from each above-mentioned electrode, and is crooked, and is pulled out by the end face of the above-mentioned passage substrate.

[Claim 2] The above-mentioned electrode connection is an ink-jet recording device according to claim 1 characterized by extending further, and being crooked and being pulled out by even the base of the above-mentioned passage substrate after extending from each above-mentioned electrode, and being crooked and being pulled out by the end face of the above-mentioned passage substrate.

[Claim 3] The ink-jet recording device according to claim 2 characterized by preparing the drive circuit element connected with the above-mentioned electrode connection in the above-mentioned base.

[Claim 4] The above-mentioned electrode connection is an ink-jet recording device according to claim 1 to 3 characterized by forming a metal membrane in the vadum formed in the above-mentioned end face or the above-mentioned base.

[Claim 5] The ink-jet recording device according to claim 1 to 4 characterized by having fixed the manifold which has the common ink room which supplies ink to each above-mentioned ink passage in either of the end faces of the above-mentioned passage substrate.

[Claim 6] Two or more above-mentioned electrode connections are ink-jet recording devices according to claim 1 to 5 characterized by being formed in an one end-face [of the above-mentioned passage substrate], and other-end side side by turns.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention relates to the ink-jet recording device which records by the regurgitation of an ink drop.
[0002]
[Description of the Prior Art] Conventionally, the ink-jet recording device which forms ink passage in the piezoelectric material itself is indicated by JP,2-150355,A etc. The cross section of a direction which was along ink passage at drawing 21 about the cross section of a direction perpendicular to the passage of such an ink-jet recording device is shown in drawing 22 . This recording device engraves the ink passage 51 of the shape of two or more slot on the passage substrate 50 which consists of piezoelectric material by which polarization was carried out in the thickness direction by cutting etc. After forming an electrode 53 in the both-sides side of the passage septum 52 which has divided the ink passage of these plurality, By joining a cover plate 54 to this passage substrate upper surface, and joining the nozzle plate 56 in which the nozzle 55 for carrying out the regurgitation of the ink drop was formed to the passage outlet end face of the passage substrate 50, each nozzle 55 is made to open each ink passage 51 for free passage, respectively, and it is constituted. An electrode 53 is pulled out even behind [that the ink passage 51 on the passage substrate 50 was formed / passage] a field, serves as the electrode connection 57, and is electrically connected with the external electrical circuit (not shown) there. If driver voltage is supplied to this electrode 53, electric field with the direction 58 of polarization perpendicular in the passage septum 52 will occur, the passage septum 52 bends in shearing mode toward the passage 51 inside, the ink in passage is pressurized, and the regurgitation of ink is performed from a nozzle 55. Moreover, the ink of a part consumed by the regurgitation is supplied through the common ink room 59 established in the aforementioned cover plate 54 (or passage substrate 50).
[0003] since the passage substrate itself serves as a pressure generating means using the passage substrate which these ink-jet recording devices become from piezoelectric material -- a pressure source -- others -- it is not necessary to prepare -- passage -- and it is alike and excels in the densification of a nozzle
[0004]
[Problem(s) to be Solved by the Invention] However, as for the ink-jet recording device of these former, in addition to the electrode connection 57 with an external electrical circuit being formed on the same field as the passage engraving side of the passage substrate 50, the common ink room 59 is formed in the cover plate 54 or the passage substrate 50. That is, passage 51 the very thing is formed from the end side of the passage substrate 50 to pars intermedia, but the electrode connection 57 and the common ink room 59 exist in the back. Therefore, the length of a cover plate 54 is very big at the passage substrate 50 row, and it had become the hindrance of a miniaturization and lightweight-izing from the length of the ink passage (pressurization section) 51 required to inject an ink drop originally. If it explains concretely using drawing 22 , the overall length of the passage substrate containing the common ink room 59 and the electrode connection 57 is 15-25mm to the ink passage (pressurization section) used in order to carry out the regurgitation of the ink drop being the portion shown by L all over drawing from the nozzle side edge side to the common ink room 59, and usually serving as a length of about L= 2-10mm. Thus, in the conventional ink-jet recording device, it was difficult to shorten the length of the direction of passage, and it had become small and the hindrance of lightweight-izing. Moreover, in the material which constitutes the ink-jet recording device principal part, piezoelectric material was the most expensive, and by the conventional method, since there was much amount of the piezoelectric material used, it caused cost quantity. Moreover, conventionally, with composition, in addition to the ink passage (pressurization section) 51, also in the common ink room 59 and the electrode connection 57, electric capacity was formed by inter-electrode, and the consumed electric current and power were increasing more than required.
[0005] this invention solves the above-mentioned technical problem, and aims at achievement of low-cost[a miniaturization, lightweight-izing, and]-izing and low-power-izing in the ink-jet recording device from which the passage substrate itself serves as a pressure generating means using the passage substrate which at least a part becomes from piezoelectric material.
[0006]
[The means for solving invention] The passage substrate in which two or more electrodes are prepared corresponding to each ink passage while at least a part consists of piezoelectric material and the ink passage of the shape of two or more slot is engraved in this invention, in order to attain the above-mentioned purpose, The cover plate which has fixed to the ink passage forming face of a passage substrate, and the nozzle plate which has two or more nozzles which have fixed to the end side of a passage substrate and are open for free passage with the opening edge of each ink passage, respectively, It is characterized by having the electrode

connection which extends from each electrode, and is crooked and is pulled out by the end face of a passage substrate. In addition, after extending an electrode connection from each electrode, and crooking it and being pulled out by the end face of a passage substrate, it is extended further, and is crooked and may be pulled out by even the base of a passage substrate. In this case, the drive circuit element connected with an electrode connection can also be prepared in a base. An electrode connection can do manufacture easily, if a metal membrane is formed in the vadum formed in the end face or the base. Preferably, in either of the end faces of a passage substrate, the manifold which has the common ink room which supplies ink to each ink passage fixes. Two or more electrode connections can also be formed in an one end-face [of a passage substrate], and other-end side side by turns.
[0007]
[Embodiments of the Invention] Hereafter, the detail of this invention is explained along with an accompanying drawing. The cross section with which drawing 1 met in the direction of passage of the 1st example of this invention, and drawing 2 are the rear view which looked at the 1st example of this invention from passage back.
[0008] The principal part of the ink-jet recording device by this invention is constituted by the passage substrate 1 which consists of piezoelectric material, the cover plate 2 joined to the passage substrate upper surface, and the nozzle plate 3 joined by the end side of the passage substrate 1. The ink passage 4 of the shape of two or more slot is engraved on the passage substrate 1 upper surface by cutting etc., and opening of this ink passage 4 is carried out to the end face of the passage substrate 1. The electrode 6 is formed in the both-sides side of the passage septum 5 which has divided the ink passage 4. Moreover, the nozzle plate 3 is fixed to the end face of the passage substrate 1, and the ** nozzle 7 which is open for free passage to each ink passage 4, and breathes out an ink drop to this nozzle plate 3 is formed. The length of the direction of passage of the passage substrate 1 and a cover plate 2 is substantially constituted equally with length L of the ink passage 4 which is the portion which applies a pressure to ink. Moreover, an electrode 6 is formed covering ink passage 4 overall length, and is further formed also in passage substrate 1 end face (setting to this example, a nozzle plate 3 is the passage back end face of an opposite side) located right-angled with this ink passage 4 continuously.
[0009] Next, the manufacture method of the passage substrate 1 used for the ink-jet recording device of this 1st example is explained using drawing 3 . In addition, drawing 3 is process drawing explaining the manufacture method of the passage substrate 1 used for the 1st example, and serves as front view of a passage substrate back end face. First, as shown in drawing 3 (a), the ink passage 4 of two or more shape of a in general parallel slot is formed in the substrate 1 by which consists of piezoelectric material, such as PZT, and polarization is carried out in the thickness direction as the 1st process by machine cutting, such as a dicing saw. For the passage substrate 1, the passage depth is [the thickness of the septum 5 which divides 50 micrometers - 200 micrometers and passage of 200 micrometers - 1mm and the depth] 50 micrometers - 200 micrometers by length of 2mm - 10mm, and the thickness of about 0.5-2mm.
[0010] The 2nd process forms electrode layer 6a in the passage substrate 1 into which passage was processed as shown in drawing 3 (b) all over including the inside of passage 4 by the spatter or electroless deposition. An electrode material is formed by the thickness of 0.1 micrometers - 3 micrometers by aluminum, nickel, Cr, Au, etc. The 3rd process is separation formation of an electrode 6. In this example, polarization of the piezoelectric passage substrate 1 is carried out in the substrate thickness direction, by impressing electric field perpendicular to the direction 8 of polarization to the passage septum 5, a septum 5 deforms toward the ink passage 4 inside in shearing mode, and an ink drop is breathed out from a nozzle 7. in order to perform this ink **** efficiently -- an electrode 6 -- the height direction of the passage septum 5, as it needs to be formed in general to the half and shown in drawing 3 (c) Laser beam 9a by excimer lasers, such as an YAG laser, and F2, ArF, KrF, XeCl, XeF, is irradiated aslant in a passage substrate 1 passage side. By using passage septum 5 the very thing as a mask, only an upper half can remove electrode layer 6a of a passage side in general, and the electrode 6 of a desired configuration can be obtained in the lower half.
[0011] Moreover, in a nozzle plate 3, the passage back end face of an opposite side irradiates the aforementioned laser beam 9b, after protecting the required section with the metal masks 10, such as phosphor bronze, and it carries out separation formation of the electrode connection 11 for supplying power from an external electrical circuit (not shown) as shown in drawing 3 (d). Thus, the passage substrate 1 in which a desired electrode 6 and the desired electrode connection 11 were formed can be obtained. In addition, complete irradiation of the aforementioned laser or mechanical polish removes electrode layer 6a prepared in the nozzle side edge side of the passage substrate 1, the ends side parallel to passage 4, and the base.
[0012] Thus, the cover plate 2 with a thickness of about 0.2-2mm is joined to the created passage substrate 1 for example, with epoxy system adhesives by PZT, ceramics, glass, plastics, etc.
[0013] Next, process it by laser radiation, and form, or join the nozzle plate 3 which was made from the polyimide film and was formed by electrocasting or the micro press method by being made from a metal to passage substrate 1 end face, each ink passage 4 is made to open each nozzle 7 for free passage, and the principal part of the ink-jet recording device of this example shown in drawing 1 is completed.
[0014] Next, the manifold 12 for ink supply which has common ink room 12a in the interior is joined to a passage back end face. The cables 13, such as FPC by which the wiring for finally supplying a voltage waveform to the aforementioned electrode from an external electrical circuit (not shown) was made, or heat sealing, are connected to the aforementioned electrode connection 11 in which it was prepared by the end face of the passage substrate 1, and the ink-jet recording device of this example shown in drawing 4 is completed.
[0015] the length of the passage substrate 1 which had become 15mm - 25mm and a big thing by the conventional method according to this example -- the length of the ink passage 4 -- substantial -- etc. -- carrying out -- it is -- 2mm - 10mm -- large -- small -- it can carry out -- an ink-jet recording device -- below the conventional half -- small ---izing can be carried out

lightweight] Moreover, although the piezoelectric material which forms the passage substrate 1 is the most expensive in raw material, by having miniaturized, a material cost is halved and an ink-jet recording device can be low-cost-ized. Moreover, addition capacity other than the ink passage section can decrease and low-power-ize by having miniaturized.

[0016] The perspective diagram of the passage back section of the principal part of the 2nd example is shown for process drawing which explains to drawing 5 the manufacture method of the passage substrate 14 used for the ink-jet recording device which is the 2nd example of this invention in drawing 6 . The manufacture method of the passage substrate 14 used for the ink-jet recording device of the 2nd example is explained using drawing 5 seen from the passage back end face. In addition, the thing without publications, such as a material name and a size, is the same as the 1st example. The 1st process forms the ink passage 4 of two or more shape of a in general parallel slot in the piezoelectric passage substrate 14 by machine cutting, such as a dicing saw, as shown in drawing 5 (a). Next, **** 15 which stood in a row in each passage 4 in the field in which passage 4 was formed, and the end face which makes a right angle is machined. Although the depth of **** 15 is 3 micrometers or more of the thickness maximum of an electrode as a requirement, in consideration of machining precision, its 5 micrometers or more are desirable. Moreover, if too not much deep, in order to cause trouble to electrical installation with a cable 13, it is desirable to be referred to as 30 micrometers or less. It is almost the same as the passage section, for example, the width of face of **** 15 is 50 micrometers - 200 micrometers.

[0017] The 2nd process forms electrode layer 16a in the whole surface by the spatter or electroless deposition at the piezoelectric passage substrate 14 into which passage 4 was processed as shown in drawing 5 (b). And the 3rd process is separation formation of an electrode 16. The laser beams 17, such as excimer lasers, such as an YAG laser, and F2, ArF, KrF, XeCl, XeF, are irradiated aslant in a passage substrate passage side, and only an upper half can remove electrode layer 16a of a passage side in general by using passage septum 5 the very thing as a mask.

[0018] Moreover, if the end face of passage back is ground to the grade whose **** 15 is not lost by the mechanical method, only the electrode layer in **** 15 will remain, and as shown in drawing 5 (c), separation formation of the electrode connection 18 for supplying power to a passage end face from an external electrical circuit will be carried out.

[0019] According to this example, the metal mask for forming an electrode pattern in a passage back end face which was used in the 1st example becomes unnecessary, and can simplify a manufacturing process.

[0020] The rear view which looked at the 3rd example from passage back to drawing 7 is shown. In the 3rd example, since the passage substrate 20 which made two piezoelectric substrates 20a and 20b from which the direction 19 of polarization differed rival is used and the deformation direction by the shearing mode of the upper and lower sides of a passage septum becomes the same, it becomes unnecessary only for a half to remove an electrode 21, and a manufacturing process can be facilitated further.

[0021] The rear view which looked at the 4th example from passage back to drawing 8 is shown. In the 4th example, if voltage is impressed between the electrode 24 which heights 23 were formed in the lower part of each passage 4 created by the piezoelectric passage substrate 22, and was prepared in the heights upper surface, and the electrode 25 prepared in the lower part, into heights, electric field parallel to the direction 26 of polarization will occur, heights 23 will deform toward the drawing upper part by the piezo-electric longitudinal mode, a pressure will occur in the ink in ink passage, and an ink drop will be breathed out. The electrode 24 on the upper surface of heights is pulled out by the end face perpendicular to the passage 4 of the passage substrate 22 by the same method as the aforementioned method, and serves as an external electrical circuit and the electrode connection 27 by which electric connection is made by the end face. Thus, this invention is applicable not only in the ink-jet recording device which used shearing mode.

[0022] The cross section which met in the direction of passage of the 5th example at drawing 9 is shown. In the 5th example, an electrode 6 is pulled out by the same end face as the field where the nozzle plate 3 of the passage substrate 1 is joined, and the electrical installation of the electrode connection 28 and a cable 13 is made on the nozzle plate side edge side. By this composition, the flexibility of cable wiring increases and the whole recording device can be miniaturized further. In addition, when the crevice between some is generated between the passage substrate 1 and a nozzle plate 3 in the portion in which the electrode connection 29 does not exist, the seal of the adhesives for nozzle plate 3 adhesion is filled up with and carried out.

[0023] The cross section which met in the direction of passage of the 6th example at drawing 10 is shown. In the 6th example, an electrode 6 is pulled out by turns by the ends side of the end face to which the nozzle plate 3 of the passage substrate 1 is joined, and the end face of an opposite side every other passage, the electrical installation of the electrode connections 29 and 30 and a cable 13 is made on an ends side, and it connects with the external electrical circuit. If a passage pitch is conventionally set to about 100 micrometers or less, by taking this composition, the difficult electrode connection can make the pitch of an electrode connection twice a passage pitch, and can realize a high definition recording device.

[0024] The 7th example is shown in drawing 11 -14. The electrode 6 is pulled out by even the passage substrate base (a passage forming face and field of an opposite side) through the inside of the ink passage 4, and passage substrate 1 end face. That is, electrode layer 6a is formed in the passage substrate 1 in which it became from piezoelectric material and the ink passage 4 was formed all over including a base. Laser beam 9a as shown in drawing 3 (a) is irradiated aslant in a passage substrate passage side, and by using passage septum 5 the very thing as a mask, only an upper half removes electrode 6a of a passage side in general, and it leaves an electrode 6 to a lower half. Moreover, in a nozzle plate 3, the passage back end face and passage substrate base of an opposite side irradiate laser beam 9b, after protecting the required section with the metal masks 32, such as phosphor bronze, and they form the electrode connection 31 for supplying power from an external electrical circuit as shown in drawing 3 (b). In addition, complete irradiation of the aforementioned laser or mechanical polish removes electrode layer 6a of the nozzle side edge side of a passage substrate, and an ends side parallel to passage.

[0025] A cover plate 2 and a nozzle plate 3 are joined to this passage substrate 1, and the principal part of an ink-jet recording device is completed. And the manifold 12 for ink supply which has common ink room 12a in the interior is joined to a passage back end face. The cable 13 for voltage supply is connected to the last at the aforementioned electrode connection 31 in which it was prepared on the base of a passage substrate, and the ink-jet recording device of this example shown in drawing 14 is completed.

[0026] The 8th example is shown in drawing 15 and 16. The 8th example forms electrode layer 35a in the whole surface, after forming **** 34 which stood in a row in each passage 11 in the position which should form an electrode connection in the field in which the passage of a passage substrate was formed, the end face which makes a right angle, and a base, as shown in drawing 15 (a). And as shown in drawing 15 (b), while irradiating a laser beam 36 and forming an electrode 6 in the passage septum 5 side, the end face in which **** 34 was formed, and a base are ground to the grade whose **** 34 is not lost by the mechanical method. Only the electrode layer in **** 34 remains by this, and as shown in drawing 15 (c), the electrode connection 37 for supplying power to passage substrate 33 base from an external electrical circuit is formed.

[0027] The front view which looked at the 9th example from passage back to drawing 17 is shown. In the 9th example, since the passage substrate 38 which made two piezoelectric substrates 38a and 38b from which the direction of polarization differed rival is used and the deformation direction by the shearing mode of the upper and lower sides of a passage septum becomes the same, it becomes unnecessary only for a half to remove an electrode 39, and a manufacturing process can be facilitated further.

[0028] The cross section which met in the direction of passage of the 10th example at drawing 18 is shown. In the 10th example, an electrode is pulled out to the base of the passage substrate 1 via the same end face as the field where the nozzle plate 3 of the passage substrate 1 is joined, and the electrode connection 41 with an external electrical circuit is made by the nozzle plate side of passage substrate 1 base. Since the manifold 12 and the electrode connection 41 for supplying the ink which had common ink room 12a in the interior which were prepared in passage back are separable with this composition, the reliability of ink sealing of a manifold 12 and the ink-jet recording device principal part can be raised.

[0029] The cross section which met in the direction of passage of the 11th example at drawing 19 is shown. In the 11th example, it is pulled out from each electrode to a part of base [at least] of a passage substrate via two end faces of the passage substrate 1 by turns every other passage, and the electrode connections 42 and 43 are formed. And the electrical installation of the electrode connections 42 and 43 and a cable 13 is made on the base of the passage substrate 1. If a passage pitch is conventionally set to about 100 micrometers or less, the difficult electrode connection can make the pitch of an electrode connection twice a passage pitch by taking this composition, electrode connection is possible also for the passage pitch which is about 50 micrometers, and a high definition recording device can be realized.

[0030] The cross section which met in the direction of passage passage of the 12th example at drawing 20 is shown. In the 12th example, the drive circuit element 44 and the so-called IC are joined to passage substrate 1 base. The output section of the drive circuit element 44 is wire bonding etc., and is electrically connected with the electrode connection 43 pulled out to the base of a passage substrate via the end face of a passage substrate. The control signal and power to a drive circuit element are supplied through a cable 13 from an external electrical circuit (not shown). The number of electric wiring connected with the drive circuit element 44 from an external electrical circuit by carrying out the serial transfer of the data at an ink-jet recording device can be reduced sharply. In this example, it becomes possible to carry the drive circuit element 44, without enlarging the passage substrate 1 and the whole ink-jet recording device, in order to use the passage substrate base which was not used conventionally.

[0031]

[Effect of the Invention] In the ink-jet recording device in which the electrode is formed by this invention corresponding to each ink passage using the passage substrate which at least a part becomes from piezoelectric material as mentioned above Since the electrode connection pulled out from each electrode to the end face or base of a passage substrate is formed Electrical installation with an external drive circuit can be performed on an end face or a base, does not need to provide the space for electrical installation on an ink passage forming face, and can make a passage substrate and a cover plate substantially length of the same grade with ink passage. therefore -- according to this invention -- an ink-jet recording device -- below the conventional half -- small -- lightweight -- since it can do-izing, and a material cost decreases and the amount of the expensive piezoelectric material used becomes less especially by having miniaturized, offer of a cheap ink-jet recording device is attained By furthermore having miniaturized, addition capacity decreases and low-power-ization is attained. Moreover, it is still more effective if it is the composition which fixes the manifold which does not prepare a common ink room for a common ink room on a passage forming face, but has a common ink room to a passage substrate end face. It becomes possible to carry a drive circuit element, without enlarging a form passage substrate and an ink-jet recording device, in preparing an electrode connection in a passage substrate base.

[0032] A manufacturing process will become easy, if a metal membrane is formed in ****** formed in the passage substrate end face or the base and an electrode connection is constituted. If two or more above-mentioned electrode connections are formed in an one end-face [of a passage substrate], and other-end side side by turns, since the pitch of an electrical installation portion will be made to a double size rather than a passage pitch, it contributes to the densification of ink passage.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] Conventionally, the ink-jet recording device which forms ink passage in the piezoelectric material itself is indicated by JP,2-150355,A etc. The cross section of a direction which was along ink passage at drawing 21 about the cross section of a direction perpendicular to the passage of such an ink-jet recording device is shown in drawing 22 . This recording device engraves the ink passage 51 of the shape of two or more slot on the passage substrate 50 which consists of piezoelectric material by which polarization was carried out in the thickness direction by cutting etc. After forming an electrode 53 in the both-sides side of the passage septum 52 which has divided the ink passage of these plurality, By joining a cover plate 54 to this passage substrate upper surface, and joining the nozzle plate 56 in which the nozzle 55 for carrying out the regurgitation of the ink drop was formed to the passage outlet end face of the passage substrate 50, each nozzle 55 is made to open each ink passage 51 for free passage, respectively, and it is constituted. An electrode 53 is pulled out even behind [that the ink passage 51 on the passage substrate 50 was formed / passage] a field, serves as the electrode connection 57, and is electrically connected with the external electrical circuit (not shown) there. If driver voltage is supplied to this electrode 53, electric field with the direction 58 of polarization perpendicular in the passage septum 52 will occur, the passage septum 52 bends in shearing mode toward the passage 51 inside, the ink in passage is pressurized, and the regurgitation of ink is performed from a nozzle 55. Moreover, the ink of a part consumed by the regurgitation is supplied through the common ink room 59 established in the aforementioned cover plate 54 (or passage substrate 50).
[0003] since the passage substrate itself serves as a pressure generating means using the passage substrate which these ink-jet recording devices become from piezoelectric material -- a pressure source -- others -- it is not necessary to prepare -- passage -- and it is alike and excels in the densification of a nozzle

[Translation done.]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the Invention] In the ink-jet recording device in which the electrode is formed by this invention corresponding to each ink passage using the passage substrate which at least a part becomes from piezoelectric material as mentioned above Since the electrode connection pulled out from each electrode to the end face or base of a passage substrate is formed, electrical installation with an external drive circuit can be performed on an end face or a base, does not need to provide the space for electrical installation on an ink passage forming face, and can make a passage substrate and a cover plate substantially length of the same grade with ink passage. therefore -- according to this invention -- an ink-jet recording device -- below the conventional half -- small -- lightweight -- since it can do-izing, and a material cost decreases and the amount of the expensive piezoelectric material used becomes less especially by having miniaturized, offer of a cheap ink-jet recording device is attained By furthermore having miniaturized, addition capacity decreases and low-power-ization is attained. Moreover, it is still more effective if it is the composition which fixes the manifold which does not prepare a common ink room for a common ink room on a passage forming face, but has a common ink room to a passage substrate end face. It becomes possible to carry a drive circuit element, without enlarging a form passage substrate and an ink-jet recording device, in preparing an electrode connection in a passage substrate base.

[0032] A manufacturing process will become easy, if a metal membrane is formed in the vadum formed in the passage substrate end face or the base and an electrode connection is constituted. If two or more above-mentioned electrode connections are formed in an one end-face [of a passage substrate], and other-end side side by turns, since the pitch of an electrical installation portion will be made to a double size rather than a passage pitch, it contributes to the densification of ink passage.

[Translation done.]

* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, as for the ink-jet recording device of these former, in addition to the electrode connection 57 with an external electrical circuit being formed on the same field as the passage engraving side of the passage substrate 50, the common ink room 59 is formed in the cover plate 54 or the passage substrate 50. That is, passage 51 the very thing is formed from the end side of the passage substrate 50 to pars intermedia, but the electrode connection 57 and the common ink room 59 exist in the back. Therefore, the length of a cover plate 54 is very big at the passage substrate 50 row, and it had become the hindrance of a miniaturization and lightweight-izing from the length of the ink passage (pressurization section) 51 required to inject an ink drop originally. If it explains concretely using drawing 22 , the overall length of the passage substrate containing the common ink room 59 and the electrode connection 57 is 15-25mm to the ink passage (pressurization section) used in order to carry out the regurgitation of the ink drop being the portion shown by L all over drawing from the nozzle side edge side to the common ink room 59, and usually serving as a length of about L= 2-10mm. Thus, in the conventional ink-jet recording device, it was difficult to shorten the length of the direction of passage, and it had become small and the hindrance of lightweight-izing. Moreover, in the material which constitutes the ink-jet recording device principal part, piezoelectric material was the most expensive, and by the conventional method, since there was much amount of the piezoelectric material used, it caused cost quantity. Moreover, conventionally, with composition, in addition to the ink passage (pressurization section) 51, also in the common ink room 59 and the electrode connection 57, electric capacity was formed by inter-electrode, and the consumed electric current and power were increasing more than required.
[0005] this invention solves the above-mentioned technical problem, and aims at achievement of low-cost[a miniaturization, lightweight-izing, and]-izing and low-power-izing in the ink-jet recording device from which the passage substrate itself serves as a pressure generating means using the passage substrate which at least a part becomes from piezoelectric material.

[Translation done.]

* NOTICES *

MEANS

[The means for solving invention] The passage substrate in which two or more electrodes are prepared corresponding to each ink passage while at least a part consists of piezoelectric material and the ink passage of the shape of two or more slot is engraved in this invention, in order to attain the above-mentioned purpose, The cover plate which has fixed to the ink passage forming face of a passage substrate, and the nozzle plate which has two or more nozzles which have fixed to the end side of a passage substrate and are open for free passage with the opening edge of each ink passage, respectively, It is characterized by having the electrode connection which extends from each electrode, and is crooked and is pulled out by the end face of a passage substrate. In addition, after extending an electrode connection from each electrode, and crooking it and being pulled out by the end face of a passage substrate, it is extended further, and is crooked and may be pulled out by even the base of a passage substrate. In this case, the drive circuit element connected with an electrode connection can also be prepared in a base. An electrode connection can do manufacture easily, if a metal membrane is formed in the vadum formed in the end face or the base. Preferably, in either of the end faces of a passage substrate, the manifold which has the common ink room which supplies ink to each ink passage fixes. Two or more electrode connections can also be formed in an one end-face [of a passage substrate], and other-end side side by turns.
[0007]
[Embodiments of the Invention] Hereafter, the detail of this invention is explained along with an accompanying drawing. The cross section with which drawing 1 met in the direction of passage of the 1st example of this invention, and drawing 2 are the rear view which looked at the 1st example of this invention from passage back.
[0008] The principal part of the ink-jet recording device by this invention is constituted by the passage substrate 1 which consists of piezoelectric material, the cover plate 2 joined to the passage substrate upper surface, and the nozzle plate 3 joined by the end side of the passage substrate 1. The ink passage 4 of the shape of two or more slot is engraved on the passage substrate 1 upper surface by cutting etc., and opening of this ink passage 4 is carried out to the end face of the passage substrate 1. The electrode 6 is formed in the both-sides side of the passage septum 5 which has divided the ink passage 4. Moreover, the nozzle plate 3 is fixed to the end face of the passage substrate 1, and the ** nozzle 7 which is open for free passage to each ink passage 4, and breathes out an ink drop to this nozzle plate 3 is formed. The length of the direction of passage of the passage substrate 1 and a cover plate 2 is substantially constituted equally with length L of the ink passage 4 which is the portion which applies a pressure to ink. Moreover, an electrode 6 is formed covering ink passage 4 overall length, and is further formed also in passage substrate 1 end face (setting to this example, a nozzle plate 3 is the passage back end face of an opposite side) located right-angled with this ink passage 4 continuously.
[0009] Next, the manufacture method of the passage substrate 1 used for the ink-jet recording device of this 1st example is explained using drawing 3 . In addition, drawing 3 is process drawing explaining the manufacture method of the passage substrate 1 used for the 1st example, and serves as front view of a passage substrate back end face. First, as shown in drawing 3 (a), the ink passage 4 of two or more shape of a in general parallel slot is formed in the substrate 1 by which consists of piezoelectric material, such as PZT, and polarization is carried out in the thickness direction as the 1st process by machine cutting, such as a dicing saw. For the passage substrate 1, the passage depth is [the thickness of the septum 5 which divides 50 micrometers - 200 micrometers and passage of 200 micrometers - 1mm and the depth] 50 micrometers - 200 micrometers by length of 2mm - 10mm, and the thickness of about 0.5-2mm.
[0010] The 2nd process forms electrode layer 6a in the passage substrate 1 into which passage was processed as shown in drawing 3 (b) all over including the inside of passage 4 by the spatter or electroless deposition. An electrode material is formed by the thickness of 0.1 micrometers - 3 micrometers by aluminum, nickel, Cr, Au, etc. The 3rd process is separation formation of an electrode 6. In this example, polarization of the piezoelectric passage substrate 1 is carried out in the substrate thickness direction, by impressing electric field perpendicular to the direction 8 of polarization to the passage septum 5, a septum 5 deforms toward the ink passage 4 inside in shearing mode, and an ink drop is breathed out from a nozzle 7. in order to perform this ink **** efficiently -- an electrode 6 -- the height direction of the passage septum 5, as it needs to be formed in general to the half and shown in drawing 3 (c) Laser beam 9a by excimer lasers, such as an YAG laser, and F2, ArF, KrF, XeCl, XeF, is irradiated aslant in a passage substrate 1 passage side. By using passage septum 5 the very thing as a mask, only an upper half can remove electrode layer 6a of a passage side in general, and the electrode 6 of a desired configuration can be obtained in the lower half.
[0011] Moreover, in a nozzle plate 3, the passage back end face of an opposite side irradiates the aforementioned laser beam 9b, after protecting the required section with the metal masks 10, such as phosphor bronze, and it carries out separation formation of the electrode connection 11 for supplying power from an external electrical circuit (not shown) as shown in drawing 3 (d). Thus,

the passage substrate 1 in which a desired electrode 6 and the desired electrode connection 11 were formed can be obtained. In addition, complete irradiation of the aforementioned laser or mechanical polish removes electrode layer 6a prepared in the nozzle side edge side of the passage substrate 1, the ends side parallel to passage 4, and the base.

[0012] Thus, the cover plate 2 with a thickness of about 0.2-2mm is joined to the created passage substrate 1 for example, with epoxy system adhesives by PZT, ceramics, glass, plastics, etc.

[0013] Next, process it by laser radiation, and form, or join the nozzle plate 3 which was made from the polyimide film and was formed by electrocasting or the micro press method by being made from a metal to passage substrate 1 end face, each ink passage 4 is made to open each nozzle 7 for free passage, and the principal part of the ink-jet recording device of this example shown in drawing 1 is completed.

[0014] Next, the manifold 12 for ink supply which has common ink room 12a in the interior is joined to a passage back end face. The cables 13, such as FPC by which the wiring for finally supplying a voltage waveform to the aforementioned electrode from an external electrical circuit (not shown) was made, or heat sealing, are connected to the aforementioned electrode connection 11 in which it was prepared by the end face of the passage substrate 1, and the ink-jet recording device of this example shown in drawing 4 is completed.

[0015] the length of the passage substrate 1 which had become 15mm - 25mm and a big thing by the conventional method according to this example -- the length of the ink passage 4 -- substantial -- etc. -- carrying out -- it is -- 2mm - 10mm -- large -- small -- it can carry out -- an ink-jet recording device -- below the conventional half -- small ---izing can be carried out lightweight] Moreover, although the piezoelectric material which forms the passage substrate 1 is the most expensive in raw material, by having miniaturized, a material cost is halved and an ink-jet recording device can be low-cost-ized. Moreover, addition capacity other than the ink passage section can decrease and low-power-ize by having miniaturized.

[0016] The perspective diagram of the passage back section of the principal part of the 2nd example is shown for process drawing which explains to drawing 5 the manufacture method of the passage substrate 14 used for the ink-jet recording device which is the 2nd example of this invention in drawing 6 . The manufacture method of the passage substrate 14 used for the ink-jet recording device of the 2nd example is explained using drawing 5 seen from the passage back end face. In addition, the thing without publications, such as a material name and a size, is the same as the 1st example. The 1st process forms the ink passage 4 of two or more shape of a in general parallel slot in the piezoelectric passage substrate 14 by machine cutting, such as a dicing saw, as shown in drawing 5 (a). Next, **** 15 which stood in a row in each passage 4 in the field in which passage 4 was formed, and the end face which makes a right angle is machined. Although the depth of **** 15 is 3 micrometers or more of the thickness maximum of an electrode as a requirement, in consideration of machining precision, its 5 micrometers or more are desirable. Moreover, if too not much deep, in order to cause trouble to electrical installation with a cable 13, it is desirable to be referred to as 30 micrometers or less. It is almost the same as the passage section, for example, the width of face of **** 15 is 50 micrometers - 200 micrometers.

[0017] The 2nd process forms electrode layer 16a in the whole surface by the spatter or electroless deposition at the piezoelectric passage substrate 14 into which passage 4 was processed as shown in drawing 5 (b). And the 3rd process is separation formation of an electrode 16. The laser beams 17, such as excimer lasers, such as an YAG laser, and F2, ArF, KrF, XeCl, XeF, are irradiated aslant in a passage substrate passage side, and only an upper half can remove electrode layer 16a of a passage side in general by using passage septum 5 the very thing as a mask.

[0018] Moreover, if the end face of passage back is ground to the grade whose **** 15 is not lost by the mechanical method, only the electrode layer in **** 15 will remain, and as shown in drawing 5 (c), separation formation of the electrode connection 18 for supplying power to a passage end face from an external electrical circuit will be carried out.

[0019] According to this example, the metal mask for forming an electrode pattern in a passage back end face which was used in the 1st example becomes unnecessary, and can simplify a manufacturing process.

[0020] The rear view which looked at the 3rd example from passage back to drawing 7 is shown. In the 3rd example, since the passage substrate 20 which made two piezoelectric substrates 20a and 20b from which the direction 19 of polarization differed rival is used and the deformation direction by the shearing mode of the upper and lower sides of a passage septum becomes the same, it becomes unnecessary only for a half to remove an electrode 21, and a manufacturing process can be facilitated further.

[0021] The rear view which looked at the 4th example from passage back to drawing 8 is shown. In the 4th example, if voltage is impressed between the electrode 24 which heights 23 were formed in the lower part of each passage 4 created by the piezoelectric passage substrate 22, and was prepared in the heights upper surface, and the electrode 25 prepared in the lower part, into heights, electric field parallel to the direction 26 of polarization will occur, heights 23 will deform toward the drawing upper part by the piezo-electric longitudinal mode, a pressure will occur in the ink in ink passage, and an ink drop will be breathed out. The electrode 24 on the upper surface of heights is pulled out by the end face perpendicular to the passage 4 of the passage substrate 22 by the same method as the aforementioned method, and serves as an external electrical circuit and the electrode connection 27 by which electric connection is made by the end face. Thus, this invention is applicable not only in the ink-jet recording device which used shearing mode.

[0022] The cross section which met in the direction of passage of the 5th example at drawing 9 is shown. In the 5th example, an electrode 6 is pulled out by the same end face as the field where the nozzle plate 3 of the passage substrate 1 is joined, and the electrical installation of the electrode connection 28 and a cable 13 is made on the nozzle plate side edge side. By this composition, the flexibility of cable wiring increases and the whole recording device can be miniaturized further. In addition, when the crevice between some is generated between the passage substrate 1 and a nozzle plate 3 in the portion in which the

electrode connection 29 does not exist, the seal of the adhesives for nozzle plate 3 adhesion is filled up with and carried out.
[0023] The cross section which met in the direction of passage of the 6th example at drawing 10 is shown. In the 6th example, an electrode 6 is pulled out by turns by the ends side of the end face to which the nozzle plate 3 of the passage substrate 1 is joined, and the end face of an opposite side every other passage, the electrical installation of the electrode connections 29 and 30 and a cable 13 is made on an ends side, and it connects with the external electrical circuit. If a passage pitch is conventionally set to about 100 micrometers or less, by taking this composition, the difficult electrode connection can make the pitch of an electrode connection twice a passage pitch, and can realize a high definition recording device.
[0024] The 7th example is shown in drawing 11 -14. The electrode 6 is pulled out by even the passage substrate base (a passage forming face and field of an opposite side) through the inside of the ink passage 4, and passage substrate 1 end face. That is, electrode layer 6a is formed in the passage substrate 1 in which it became from piezoelectric material and the ink passage 4 was formed all over including a base. Laser beam 9a as shown in drawing 3 (a) is irradiated aslant in a passage substrate passage side, and by using passage septum 5 the very thing as a mask, only an upper half removes electrode 6a of a passage side in general, and it leaves an electrode 6 to a lower half. Moreover, in a nozzle plate 3, the passage back end face and passage substrate base of an opposite side irradiate laser beam 9b, after protecting the required section with the metal masks 32, such as phosphor bronze, and they form the electrode connection 31 for supplying power from an external electrical circuit as shown in drawing 3 (b). In addition, complete irradiation of the aforementioned laser or mechanical polish removes electrode layer 6a of the nozzle side edge side of a passage substrate, and an ends side parallel to passage.
[0025] A cover plate 2 and a nozzle plate 3 are joined to this passage substrate 1, and the principal part of an ink-jet recording device is completed. And the manifold 12 for ink supply which has common ink room 12a in the interior is joined to a passage back end face. The cable 13 for voltage supply is connected to the last at the aforementioned electrode connection 31 in which it was prepared on the base of a passage substrate, and the ink-jet recording device of this example shown in drawing 14 is completed.
[0026] The 8th example is shown in drawing 15 and 16. The 8th example forms electrode layer 35a in the whole surface, after forming **** 34 which stood in a row in each passage 11 in the position which should form an electrode connection in the field in which the passage of a passage substrate was formed, the end face which makes a right angle, and a base, as shown in drawing 15 (a). And as shown in drawing 15 (b), while irradiating a laser beam 36 and forming an electrode 6 in the passage septum 5 side, the end face in which **** 34 was formed, and a base are ground to the grade whose **** 34 is not lost by the mechanical method. Only the electrode layer in **** 34 remains by this, and as shown in drawing 15 (c), the electrode connection 37 for supplying power to passage substrate 33 base from an external electrical circuit is formed.
[0027] The front view which looked at the 9th example from passage back to drawing 17 is shown. In the 9th example, since the passage substrate 38 which made two piezoelectric substrates 38a and 38b from which the direction of polarization differed rival is used and the deformation direction by the shearing mode of the upper and lower sides of a passage septum becomes the same, it becomes unnecessary only for a half to remove an electrode 39, and a manufacturing process can be facilitated further.
[0028] The cross section which met in the direction of passage of the 10th example at drawing 18 is shown. In the 10th example, an electrode is pulled out to the base of the passage substrate 1 via the same end face as the field where the nozzle plate 3 of the passage substrate 1 is joined, and the electrode connection 41 with an external electrical circuit is made by the nozzle plate side of passage substrate 1 base. Since the manifold 12 and the electrode connection 41 for supplying the ink which had common ink room 12a in the interior which were prepared in passage back are separable with this composition, the reliability of ink sealing of a manifold 12 and the ink-jet recording device principal part can be raised.
[0029] The cross section which met in the direction of passage of the 11th example at drawing 19 is shown. In the 11th example, it is pulled out from each electrode to a part of base [at least] of a passage substrate via two end faces of the passage substrate 1 by turns every other passage, and the electrode connections 42 and 43 are formed. And the electrical installation of the electrode connections 42 and 43 and a cable 13 is made on the base of the passage substrate 1. If a passage pitch is conventionally set to about 100 micrometers or less, the difficult electrode connection can make the pitch of an electrode connection twice a passage pitch by taking this composition, electrode connection is possible also for the passage pitch which is about 50 micrometers, and a high definition recording device can be realized.
[0030] The cross section which met in the direction of passage passage of the 12th example at drawing 20 is shown. In the 12th example, the drive circuit element 44 and the so-called IC are joined to passage substrate 1 base. The output section of the drive circuit element 44 is wire bonding etc., and is electrically connected with the electrode connection 43 pulled out to the base of a passage substrate via the end face of a passage substrate. The control signal and power to a drive circuit element are supplied through a cable 13 from an external electrical circuit (not shown). The number of electric wiring connected with the drive circuit element 44 from an external electrical circuit by carrying out the serial transfer of the data at an ink-jet recording device can be reduced sharply. In this example, it becomes possible to carry the drive circuit element 44, without enlarging the passage substrate 1 and the whole ink-jet recording device, in order to use the passage substrate base which was not used conventionally.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the cross section which met in the direction of passage of the 1st example of this invention.
[Drawing 2] It is the rear view which looked at the 1st example from passage back.
[Drawing 3] It is explanatory drawing of the manufacture method of the passage substrate of the 1st example.
[Drawing 4] It is the cross section of the whole equipment of the 1st example.
[Drawing 5] It is explanatory drawing of the manufacture method of the passage substrate of the 2nd example.
[Drawing 6] It is the perspective diagram of the passage back section of the important section of the 2nd example.
[Drawing 7] It is the rear view which looked at the 3rd example from passage back.
[Drawing 8] It is the rear view which looked at the 4th example from passage back.
[Drawing 9] It is the cross section which met in the direction of passage of the 5th example.
[Drawing 10] It is the cross section which met in the direction of passage of the 6th example.
[Drawing 11] It is the cross section which met in the direction of passage of the 7th example.
[Drawing 12] It is the rear view which looked at the 7th example from passage back.
[Drawing 13] It is explanatory drawing of the manufacture method of the passage substrate of the 7th example.
[Drawing 14] It is the cross section of the whole equipment of the 7th example.
[Drawing 15] It is explanatory drawing of the manufacture method of the passage substrate of the example of the octavus.
[Drawing 16] It is the perspective diagram of the passage back section of the important section of the example of the octavus.
[Drawing 17] It is the rear view which looked at the 9th example from passage back.
[Drawing 18] It is the cross section which met in the direction of passage of the 10th example.
[Drawing 19] It is the cross section which met in the direction of passage of the 11th example.
[Drawing 20] It is the cross section which met in the direction of passage of the 12th example.
[Drawing 21] It is the cross section of a direction perpendicular to the passage of the conventional example.
[Drawing 22] It is the cross section which met in the direction of passage of the conventional example.
[Description of Notations]
1, 14, 20, 22, 33, 38 ... Passage substrate
2 ... Cover plate
3 ... Nozzle plate
4 ... Ink passage
5 ... Passage septum
6, 21, 24, 25, 39 ... Electrode
7 ... Nozzle
11, 18, 27, 28, 29, 30, 31, 37, 41, 42, 43 ... Electrode connection
12 ... Manifold
12a .. Common ink room
15 34 ... Vadum

[Translation done.]